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**Matsuda et al.**

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(54) **VEHICLE**

(56)

**References Cited**

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**U.S. PATENT DOCUMENTS**

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1,138,122	A	5/1915	Lambert et al.	
4,445,584	A *	5/1984	Kimura et al.	180/69.22
4,738,459	A *	4/1988	Nakamura et al.	180/409
5,501,289	A *	3/1996	Nishikawa et al.	180/68.5
5,562,178	A *	10/1996	Worden et al.	180/291
5,833,023	A	11/1998	Shimizu	
6,041,877	A *	3/2000	Yamada et al.	180/65.25
6,547,020	B2 *	4/2003	Maus et al.	180/68.5
8,182,393	B2 *	5/2012	Gillingham et al.	477/8
8,480,538	B2 *	7/2013	Gillingham et al.	477/8

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(Continued)

**FOREIGN PATENT DOCUMENTS**

(21) Appl. No.: **13/788,353**

JP	4-312304	11/1992
JP	H05-208617	8/1993

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(30) **Foreign Application Priority Data**

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**ABSTRACT**

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<b>B60K 1/04</b>	(2006.01)
<b>B60K 11/06</b>	(2006.01)
<b>B60K 17/22</b>	(2006.01)
<b>B60K 1/00</b>	(2006.01)

A hybrid vehicle which is driven using the power of an engine and the power of a drive motor which is driven by an electric power supplied from a battery module, the vehicle including: a propeller shaft which is disposed below a floor panel in a vertical direction of the vehicle extending in a fore-and-aft direction of the vehicle, and is configured to transmit the power of the engine and the power of the drive motor to a rear wheel; and a battery pack having the battery module, the battery pack being disposed below the floor panel so as to cover the propeller shaft. The battery pack has a recess formed in a fore-and-aft direction of the vehicle, and the propeller shaft is housed in an air guide duct defined by the floor panel and the recess of the battery pack.

(52) **U.S. Cl.**

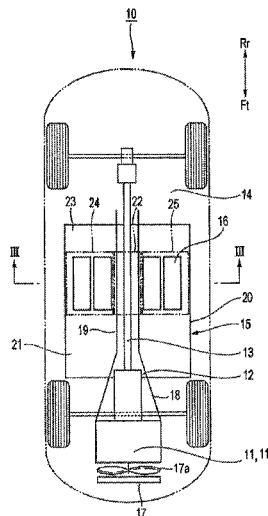
CPC ... **B60K 6/40** (2013.01); **B60K 1/04** (2013.01); **B60K 11/06** (2013.01); **B60K 17/22** (2013.01); **B60K 2001/005** (2013.01); **B60K 2001/0422** (2013.01); **B60K 2001/0438** (2013.01); **Y10S 903/951** (2013.01)

(58) **Field of Classification Search**

USPC ..... 180/65.1, 65.31, 68.5, 291, 292, 309, 180/69.1; 903/907, 951

See application file for complete search history.

**6 Claims, 4 Drawing Sheets**



(56)

**References Cited**

2013/0133961 A1 5/2013 Matsuda et al.

U.S. PATENT DOCUMENTS

8,714,289 B2 \* 5/2014 Olsen et al. .... 180/65.29  
 2010/0163322 A1 \* 7/2010 Stefani et al. .... 180/65.21  
 2010/0307848 A1 \* 12/2010 Hashimoto et al. .... 180/68.5  
 2012/0312612 A1 \* 12/2012 Harrison et al. .... 180/68.5

FOREIGN PATENT DOCUMENTS

JP 07-047842 2/1995  
 JP 2000-247261 9/2000  
 JP 2010-155570 7/2010

\* cited by examiner

FIG. 1

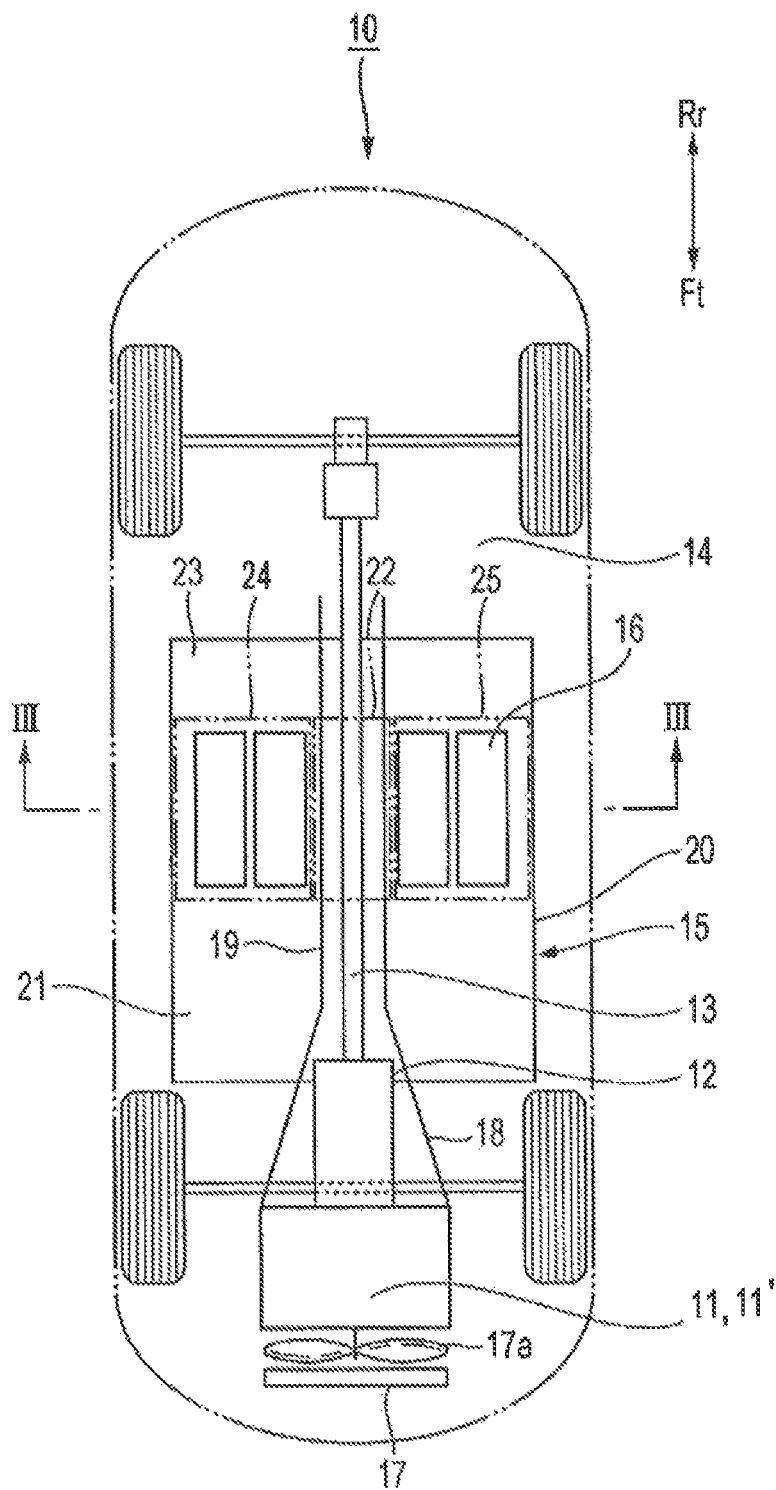


FIG. 2

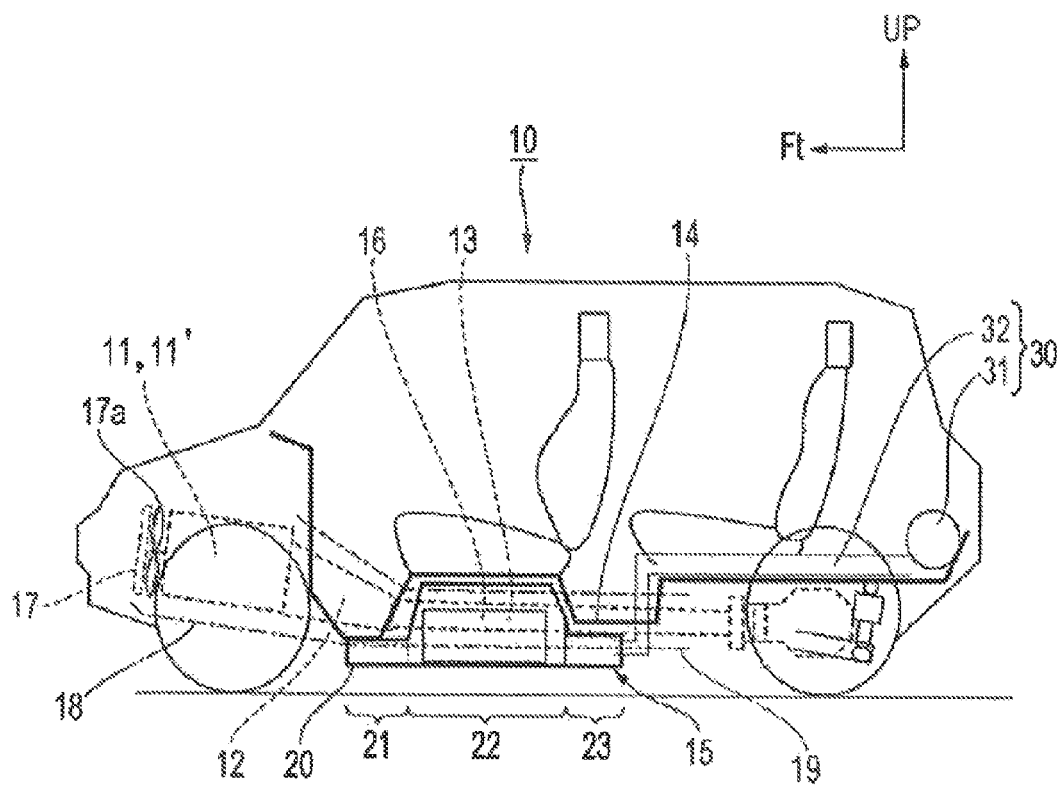


FIG. 3

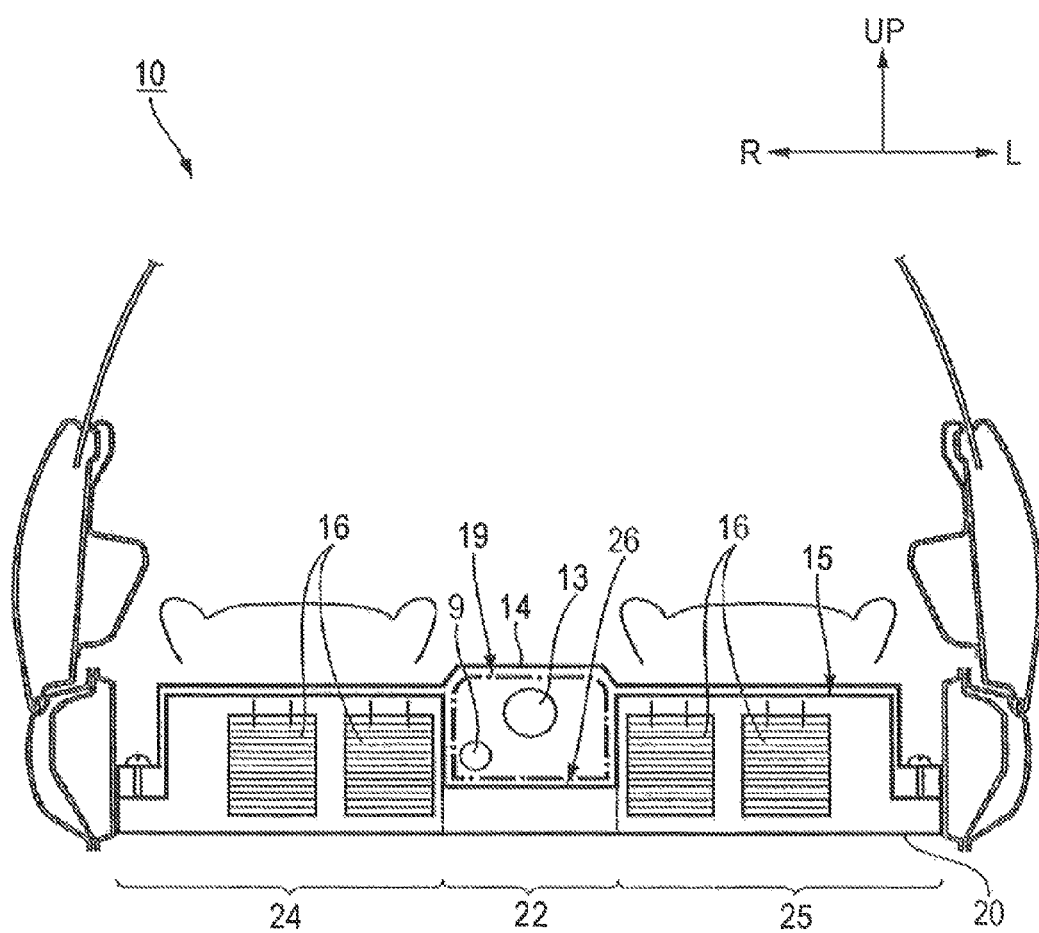


FIG. 4

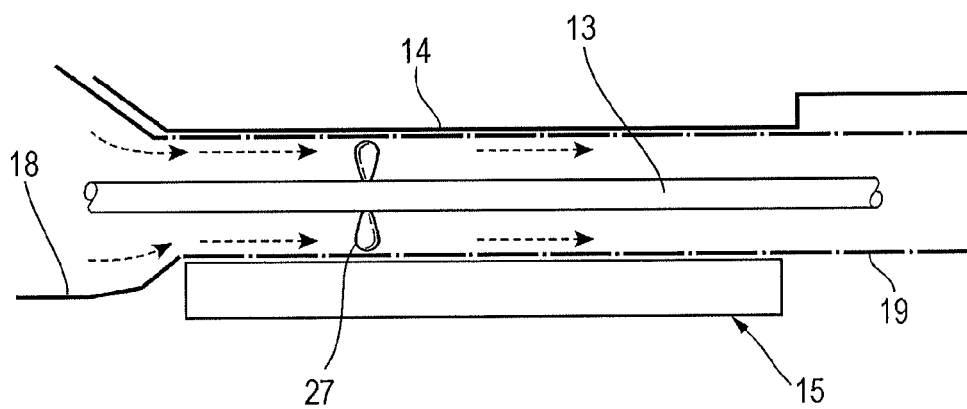
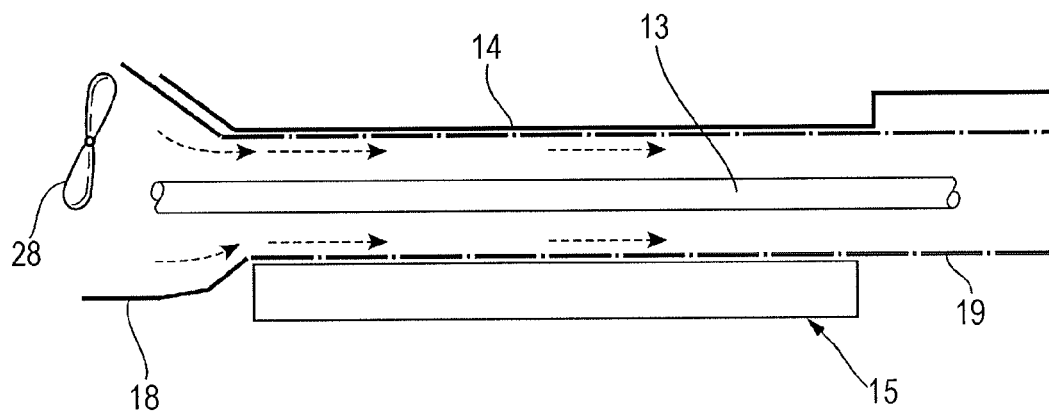


FIG. 5



# 1 VEHICLE

## CROSS-REFERENCE TO RELATED APPLICATIONS

The present application claims priority from Japanese Patent Application No. 2012-066143 filed on Mar. 22, 2012, the entire contents of which are hereby incorporated by reference.

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

The present invention relates to a vehicle, particularly to a vehicle in which a battery pack is disposed outside the vehicle cabin.

### 2. Description of the Related Art

There has been known a vehicle (so-called electric vehicle or hybrid vehicle) provided with a battery pack including a plurality of battery modules. If a hybrid vehicle is taken as an example, a typical hybrid vehicle is known to have a structure in which a battery pack is disposed on the back of the rear seat or below the luggage space.

Such a structure of a hybrid vehicle has a problem in that the presence of the battery pack reduces the trunk space behind the rear seat. In addition, the typical hybrid vehicle has a problem in that weight distribution of the vehicle in the fore-and-aft direction thereof is difficult to be adjusted due to the weight of the battery pack.

Thus, in recent years, there has been proposed a hybrid vehicle in which the battery pack is disposed below the center in the fore-and-aft direction of the vehicle, i.e., below the floor panel of the vehicle. For example, Japanese Unexamined Patent Application Publication (JP-A) No. 2000-247261 discloses a structure of the vehicle floor, in which the battery is disposed below the floor panel of the vehicle.

In addition, there has been proposed a technology for cooling a battery by supplying power from a power source for driving a vehicle or a power source for auxiliary machinery and rotating a fan for cooling the battery (JP-A No. 4-312304).

In the case of a FWD or 4WD vehicle which needs a propeller shaft, and in which a battery is installed below the floor panel of the vehicle, a plurality of batteries need to be disposed on both sides of the propeller shaft in the vehicle width direction.

In the above configuration, the battery may directly receive heat from an engine or a radiator at the front of the vehicle while the vehicle is being driven. Application of a heat insulating structure for heat damage prevention to each of a plurality of batteries disposed on both sides of the propeller shaft causes a significant increase in weight and cost.

## SUMMARY OF THE INVENTION

The present invention has been made in view of the above-mentioned problem, and it is an object of the invention to provide a vehicle capable of preventing heat damage to the battery.

An aspect of the present invention provides a vehicle which is driven using power of a drive motor which is driven by electric power supplied from a secondary battery, the vehicle including: a propeller shaft which is disposed below a floor panel in a vertical direction of the vehicle extending in a fore-and-aft direction of the vehicle, and is configured to transmit the power of the drive motor to a rear wheel; and a battery unit having the secondary battery, the battery unit

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being disposed below the floor panel so as to cover the propeller shaft. The battery unit has a recess formed in a fore-and-aft direction of the vehicle, and the propeller shaft is housed in an air guide duct defined by the floor panel and the recess of the battery unit. Thus, heat damage to the battery unit can be prevented.

Preferably, the vehicle further includes an air guide plate which is disposed extending from an internal combustion engine provided at the front of the vehicle to the above-mentioned air guide duct.

Preferably, the propeller shaft of the vehicle is provided with a first fan.

Preferably, the inlet or outlet of the air guide duct of the vehicle is provided with a second fan.

Preferably, the air guide duct of the vehicle is composed of a heat insulating material.

## BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a schematic plan view of the structure of a hybrid vehicle according to an embodiment of the present invention.

FIG. 2 is a schematic side view of the structure of a hybrid vehicle according to the embodiment of the present invention.

FIG. 3 is a cross-sectional view of the structure view taken along a line III-III in FIG. 1.

FIG. 4 is a side view of a portion including a propeller shaft and a battery pack according to the embodiment of the present invention.

FIG. 5 is a side view of a portion including a propeller shaft and a battery pack according to another embodiment of the present invention.

## DESCRIPTION OF THE PREFERRED EMBODIMENTS

Hereinafter, a hybrid vehicle according to an embodiment of the present invention will be described with reference to FIGS. 1 to 5. FIG. 1 is a schematic plan view of the structure of a hybrid vehicle 10 according to an embodiment of the present invention.

FIG. 2 is a schematic side view of the structure of the hybrid vehicle 10 according to the embodiment of the present invention, and FIG. 3 is a cross-sectional view of the structure taken along a line III-III in FIG. 1.

As illustrated in FIGS. 1 to 3, the hybrid vehicle 10 in the present embodiment includes an engine (internal combustion engine) 11, which is located at forward side in the travelling direction of the hybrid vehicle 10. The front of the engine 11 is provided with a radiator 17 and a radiator fan 17a. Although the radiator fan 17a is for cooling the radiator 17, in the present embodiment, the radiator fan 17a is configured to rotate the radiator fan 17a irrespective of the temperature of the radiator 17 so as to also serve as a fan for cooling the engine 11 and sending the heat from the engine 11 backward. The engine 11 is connected to a clutch, which is not illustrated. The clutch is then connected to a transmission 12.

That is to say, in the hybrid vehicle 10, a driving force is transmitted from the engine 11 to the transmission 12 via the clutch. The transmission 12 is achieved by using a continuously variable transmission or the like. The transmission 12 is connected to a front differential gear, which is not illustrated. In the present embodiment, transmission is performed on what is illustrated in FIGS. 1 to 3, however, transmission may be performed on another device such as a motor.

The front differential gear is connected to front-wheel drive shafts on the left and right (not illustrated). That is to say,

in the hybrid vehicle **10**, the driving force of the engine **11** is transmitted to the front-wheel drive shafts on the left and right via the front differential gear.

The transmission **12** is connected to the propeller shaft **13**. The transmission **12** includes a gear, which is not illustrated. Because the gear of the transmission **12** is engaged with the ring gear of the front differential gear, part of the driving force is transmitted to the propeller shaft **13**.

The propeller shaft **13** is provided extending in the fore-and-aft direction of the vehicle below a floor panel **14** in the vertical direction of the vehicle. The rear end of the propeller shaft **13** in the fore-and-aft direction of the vehicle is connected to a rear differential gear, which is not illustrated. The rear differential gear is connected to rear-wheel drive shafts on the left and right (not illustrated). That is to say, part of the driving force is transmitted from the propeller shaft **13** to the rear-wheel drive shafts on the left and right via the rear differential gear.

The propeller shaft **13** and an exhaust pipe **9** for exhausting an exhaust gas emitted from the engine **11** are disposed below the floor panel **14** in the vertical direction of the vehicle. In this manner, at least the propeller shaft **13** and the exhaust pipe **9** are disposed below the floor panel **14** in the vertical direction of the vehicle as described above.

In the present embodiment, in addition to the propeller shaft **13** and the exhaust pipe **9**, the hybrid vehicle **10** includes a battery pack **15** (battery unit) below the floor panel **14** in the vertical direction of the vehicle.

The battery pack **15** serves as an assembly for integrating battery modules **16**, and a BCU (battery control unit), distribution cables, a junction box, and a service plug which are not illustrated.

That is to say, the battery pack **15** is integrally formed. Here, as described above, the hybrid vehicle **10** includes the propeller shaft **13** below the floor panel **14** in the fore-and-aft direction of the vehicle.

Therefore, in the case where the battery pack **15** is mounted below the floor panel **14** of a conventional FWD or 4WD vehicle, the battery pack **15** is divided into both sides of the propeller shaft **13** in the vehicle width direction.

On the other hand, in the hybrid vehicle **10** in the present embodiment, such as a FWD or 4WD vehicle which needs the propeller shaft **13**, the integrated battery pack **15** is mounted in the vehicle as described above.

Specifically, the battery pack **15** includes a housing which is divided into the front, middle, and rear sections in the fore-and-aft direction of the vehicle, i.e., includes a front-side section **21**, a middle part, and a rear-side section **23**. The middle part of the battery pack **15** includes a middle section **22**, and a right-side section **24** and a left-side section **25** on both sides of the middle section **22** in the width direction of the vehicle.

That is to say, the housing **20** of the battery pack **15** includes five divided sections, i.e., the front-side section **21**, the middle section **22**, the rear-side section **23**, the right-side section **24** and the left-side section **25**. In the battery pack **15**, each of the battery modules **16**, the BCU (Battery Control Unit), the distribution cables, the junction box, and the service plug is disposed in one of the front-side section **21**, the middle section **22**, the rear-side section **23**, the right-side section **24** and the left-side section **25**, and thus the battery pack **15** serves as an assembly as described above.

Here, the battery modules **16**, the BCU (Battery Control Unit), the distribution cables, the junction box, and the service plug which constitute the battery pack **15** in the present embodiment are known technology, and thus detailed description is omitted and a simple description is given.

The battery modules **16** are respectively disposed in the right-side section **24** and the left-side section **25** of the battery pack **15**. Each battery module **16** has a function of supplying electrical power to a drive motor as a driving source.

In the present embodiment, as described above, the battery pack **15** is formed such that two battery modules **16** are disposed in each of the left and right sides of the propeller shaft **13** in the width direction of the vehicle. However, for example, one large battery module **16** may be disposed in each of the left and right sides of the propeller shaft **13**. Optionally, three small battery modules **16** may be disposed in each of the left and right sides of the propeller shaft **13**.

The BCU is disposed in the middle section **22** of the battery pack **15**. The BCU has a function of controlling the battery module **16**. That is to say, the BCU measures the voltages, currents, temperatures, and the like of the battery modules **16** in order to recognize the state of each of the battery modules **16**. In addition, the BCU monitors the input of electrical power to the drive motor from the battery modules **16**.

Similarly to the BCU, the distribution cables are disposed in the middle section **22** of the battery pack **15**. The distribution cables have a function of connecting the battery modules **16** to each other. The distribution cables are provided with the junction box. The junction box has functions of connecting, branching, and relaying the distribution cables.

The service plug is disposed in the front-side section **21** of the battery pack **15**. The service plug has a function of breaking a high voltage which is generated from the battery modules **16**. Thus, the service plug breaks a high voltage when the battery pack **15** is attached or detached, and thus provides safe working conditions.

In this manner, in the battery pack **15** in the present embodiment, each of the battery modules **16**, the BCU (Battery Control Unit), the distribution cables, the junction box, and the service plug is disposed in one of the front-side section **21**, the middle section **22**, the rear-side section **23**, the right-side section **24** and the left-side section **25**, and thus the battery pack **15** is integrally formed.

The housing **20** of the integrated battery pack **15** is disposed on the lower side of the floor panel **14** so as to cover the propeller shaft **13**. With the housing **20** attached to the vehicle body in this manner, a recess **26** is formed in the fore-and-aft direction of the vehicle. The recess **26** houses the propeller shaft **13** therein. Here, the battery pack **15** is disposed on the lower side of the floor panel **14** so as not to interfere with the propeller shaft **13** because of the recess **26**.

Here, the battery pack **15** in the present embodiment is disposed at the lowest point in the vertical direction of the vehicle. That is to say, the battery pack **15** is not disposed at a section with projections and recesses, such as the back of the rear seats, and thus the lower surface of the battery pack **15** in the vertical direction of the vehicle can be formed in any shape. Thus, the battery pack **15** has a smoothly formed bottom surface.

For the recess **26** defined by the floor panel **14** and the battery pack **15**, an air guide plate **18** for introducing air from the engine **11** and the radiator **17** is formed. An air guide duct **19** is defined in the recess **26** so as to contain the propeller shaft **13** and the exhaust pipe **9**. The air guide duct **19** is composed of a heat insulating material. The air guide duct **19** is formed so as to introduce air to the rear of the vehicle. Thus, air with the heat from the engine **11** and the radiator **17** can be introduced to the rear of the vehicle by the air guide plate **18** and the air guide duct **19**. Consequently, the battery modules **16** which tend to be influenced by heat can be protected from the heat from the engine **11** and the radiator **17**.



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As indicated in FIG. 4, it is also possible to mount an air guide fan 27 (a first fan) on the propeller shaft 13, and introduce air with the heat of the engine 11 by suction. In the above step, the mounting position is preferably adjusted as needed to a forward or backward position in the fore-and-aft direction of the vehicle so as to increase the effect. Alternatively, a plurality of air guide fans 27 may be mounted so as to further increase the effect.

As indicated in FIG. 5, it is also possible to mount an air guide fan 28 (a second fan) near the inlet of the air guide duct 19, and introduce air with the heat of the engine 11 by suction. It is also possible to mount the air guide fan 28 near the outlet of the air guide duct 19 so as to increase the effect. The air guide fan 28 may be attached both near the inlet and outlet, or either one of them as needed according to available space and a desired effect.

The surface of the recess 26 that faces the propeller shaft 13 may be composed of a heat insulating material. In addition, the floor panel 14 above the propeller shaft 13 may be covered with a heat insulating material. The above configuration allows the materials for producing the air guide duct 19 to be reduced, thereby providing advantages in weight and cost.

The mounting positions of the above-mentioned air guide fans 27, 28 and the number of mounting positions may be determined as needed so as to increase the effect. For example, mounting can be performed in combination such that an air guide fans 28 is mounted near the inlet of the air guide duct 19, and an air guide fans 27 is mounted on the propeller shaft 13 near the outlet of the air guide duct 19.

In this manner, the hybrid vehicle 10 in the present embodiment allows the integrated battery pack 15 to be disposed below the floor panel 14 of vehicles, so that the recess 26 defined by the floor panel 14 and the battery pack 15 serves as the air guide duct 19 for the air with the heat from the engine 11, and thus the air with the heat can be introduced to the rear of the vehicle and the battery modules 16 which tend to be influenced by heat can be protected from heat damage.

In the hybrid vehicle 10 in the present embodiment, the air guide plate 18 connects between the engine 11 or the radiator 17 and the air guide duct 19, and thus the air with the heat from the engine 11 or the radiator 17 can be exhausted to the rear of the vehicle. By mounting the air guide fan 27 to the propeller shaft 13 or mounting the air guide fan 28 to the inlet or outlet of the air guide duct 19, the air with the heat can be exhausted to the rear of the vehicle more efficiently without being in contact with the module 16.

In the present embodiment, in the hybrid vehicle 10, a cooling device 30 for supplying cooling air into the battery pack 15 is disposed in the rear-side section 23 of the battery pack 15.

The cooling device 30 includes a cooling fan 31 for sending cooling air, and a cooling duct 32 for sending the cooling air from the cooling fan 31 to the battery pack 15. The cooling fan 31 and the cooling duct 32 which constitute the cooling device 30 are known technology, and thus description is omitted.

Here, the battery pack 15 in the present embodiment is integrally formed as described above. That is to say, in the hybrid vehicle 10 in the present embodiment, the cooling air from the cooling fan 31 is sent into the battery pack 15 without branching, and thus the cooling air can be uniformly sent into the battery pack 15.

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Thus, in the hybrid vehicle 10 in the present embodiment, a variation in the temperatures of the battery modules 16 in the battery pack 15 can be suppressed.

As described above, the hybrid vehicle according to the present embodiment is a hybrid vehicle which is driven using power of an internal combustion engine, and power of a drive motor which is driven by electric power supplied from a secondary battery, the vehicle including: a propeller shaft which is disposed below a floor panel in a vertical direction of the vehicle extending in a fore-and-aft direction of the vehicle, and is configured to transmit the power of the above-mentioned internal combustion engine and the power of the drive motor to a rear wheel; and a battery unit having the secondary battery, the battery unit being disposed below the floor panel so as to cover the propeller shaft. The battery unit has a recess formed in a fore-and-aft direction of the vehicle, and the propeller shaft is housed in an air guide duct defined by the floor panel and the recess of the battery unit. Thus, heat damage to the battery unit can be prevented. Therefore, heat damage to the battery pack can be prevented.

In the present embodiment, power of the engine 11 (internal combustion engine) disposed at the front of the vehicle is transmitted to the rear wheels via the propeller shaft 13, however, the drive motor 11' is driven by electric power supplied from the secondary battery may be disposed at the front of the vehicle so as to transmit the power of the drive motor via the propeller shaft 13.

What is claimed is:

1. A vehicle which is driven using power of a drive motor which is driven by electric power supplied from a secondary battery, the vehicle comprising:
  - a propeller shaft which is disposed below a floor panel in a vertical direction of the vehicle extending in a fore-and-aft direction of the vehicle, and is configured to transmit power of the drive motor to a rear wheel; and
  - a battery unit having the secondary battery, wherein the battery unit includes a middle section, a right-side section and a left-side section in the width direction of the vehicle,
- the battery unit is disposed below the floor panel so as to cover the propeller shaft, and
- the battery unit has a recess that is open toward the floor panel formed in a fore-and-aft direction of the vehicle, and the propeller shaft is housed in an inner space enclosed by the floor panel and an upper surface of the recess which is configured as an air guide duct.
2. The vehicle according to claim 1, further comprising an air guide plate which extends from an internal combustion engine provided at a front of the vehicle to the air guide duct.
3. The vehicle according to claim 1, wherein the propeller shaft is provided with a first fan.
4. The vehicle according to claim 1, wherein the air guide duct is composed of a heat insulating material.
5. The vehicle according to claim 1, further comprising a fan provided at one or more of: an inlet of the air guide duct; an outlet of the air guide duct; and an intermediate position of the air guide duct between the inlet and the outlet.
6. The vehicle according to claim 3, wherein an inlet or outlet of the air guide duct is provided with a second fan.

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